

REMARKS

Applicants appreciate the Examiner's return of the initialed PTO-1449 Forms filed on August 14, 2000, and herewith resubmit the PTO-1449 Form including the reference AR originally filed on August 14, 2000.

Applicants have canceled claims 22 and 23 as being directed to a non-elected invention. Claims 1-21 remain pending.

The claims stand rejected as being anticipated by Kaufman et al under 35 U.S.C. § 102(b) (claims 1-3) and under 35 U.S.C. § 103(a) as being unpatentable of Kaufman in view of Chopra (claims 6, 9, 10, 13-15, 19 and 20) and further in view of Lancki (claims 4, 5, 7, 8, 11, 12, 16-18 and 21). Reconsideration of the rejections is requested for the following reasons.

Applicants have amended claims 1, 6 and 9 to set forth that the polishing liquid is abrasive-free, which is substantially free of polishing abrasives, such as alumina or silica (see page 18, line 20- page 19, line 4 of the specification). This helps to suppress dishing, erosion and scratches. Claims 13, 16 and 19 also include that the polish

liquid is claimed as containing an oxidizing substance, phosphoric acid and a protection-layer forming agent so that the polishing liquid acquires an anticorrosive effect.

On the other hand, the slurry described in Kaufman contains an abrasive, an oxidizer, a surfactant and an agent which forms a protective layer. By controlling the concentration of an additive, the selectivity of the polishing rate to the polishing plane is adjusted in Kaufman. Accordingly, Kaufman et al does not anticipate claims 1-3, as amended, and further the combination of Kaufman et al and Chopra does not render obvious independent claims 6, 9, 13, 19 and 20.


In particular, Chopra discloses a polishing solution which contains an oxidizer, an agent that forms a protective layer but that does not contain an abrasive. However, the polishing is done with a polishing pad and an abrasive. Accordingly, the rejection of the claims over Kaufman et al in view of Chopra under 35 U.S.C. § 103 should be withdrawn.

The Examiner relies upon Loncki for disclosing a carbonal-containing polymer or a polyacrylic material in the polishing liquid. However, the Loncki reference is directed to removing defects on a wafer and not to polishing a metal,

Loncki contains almost no abrasive (the abrasive is contained within the range of 0.0 to 0.5 %), the reference does not suggest to one having ordinary skill in the art to modify the polishing liquid disclosed by Kaufman in order to meet the invention as claimed by Applicants.

In view of the foregoing amendments and remarks, reconsideration and reexamination are respectfully requested.

Respectfully submitted,


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MARKED UP VERSION OF REWRITTEN CLAIMS

1. (Amended) A polishing method [comprising removing a copper film by chemical mechanical polishing using a polishing liquid containing an oxidizing substance, a phosphoric acid, and a protection-layer forming agent]for a copper film by chemical mechanical polishing, comprising forming a protection-layer with a forming agent, polishing the protection-layer away on a convex portion of the copper film, oxidizing a surface of the convex portion of the copper film by an oxidizing substance and rendering an oxidized substance, a phosphoric acid and a protection-layer forming agent and being substantially free from abrasive.

6. (Amended) A polishing method[, which comprises removing a metal film formed over an insulating film by using a polishing liquid containing an oxidizing substance, a phosphoric acid, benzotriazole, and a polymer] for removing a copper film over an insulating film by chemical mechanical polishing, comprising forming a protection-layer with benzotriazole and a polymer, polishing the protection-layer away on a convex portion of the copper film, oxidizing a surface of the convex portion of the copper film by an oxidizing substance and rendering an oxidized copper film

wherein a polishing liquid contains an oxidizing substance, a phosphoric acid, a benzotriazole and polymer and is substantially free from abrasive.

9. (Amended) A polishing method comprising [removing a first metal film of a barrier metal formed on an insulating film and a second metal film of copper formed on the surface of said first metal film, wherein said second metal film is polished using a first abrasive free polishing liquid which contains an oxidizing substance, a phosphoric acid, and a protection-layer forming agent, and said first metal film is polished using a second polishing liquid obtained by adding an abrasive to said first polishing liquid]the steps of:

(a) depositing a first metal film of a barrier metal on an insulating film having convex and concave portions, depositing a second metal film of copper on the first metal film;

(b) removing the second metal film on the convex portion and leaving the second metal film in the concave portion on the first metal by chemical mechanical polishing comprising forming a protection-layer with a forming agent on a surface of the second metal film, polishing the protection-layer away on a convex portion of the surface, oxidizing a

oxidizing substance and rendering a oxidized metal water soluble by a phosphoric acid, wherein a polishing liquid contains an oxidizing substance, a phosphoric acid and a protection-layer forming agent and is substantially free from abrasive;

(c)removing the first metal film on the convex portion and leaving the first metal in the concave portion by chemical mechanical polishing by a polishing liquid contains an oxidizing substance, a phosphoric acid, a protection-layer forming agent and abrasive.

13. (Amended) A method for manufacturing a semiconductor device, which comprises forming, over a semiconductor region, an insulating film having an opening, depositing a first metal film made of a barrier metal and a second metal film of copper over said insulating film and inside of said opening, thereby filing said opening with said deposited metal films, removing said second metal film over said insulating film by chemical mechanical polishing with a first polishing liquid containing an oxidizing substance, a phosphoric acid and a protection-layer forming agent but being free of an abrasive, thereby exposing the surface of said first metal film and said second metal film inside of said

insulating film by chemical mechanical polishing with a second polishing liquid containing an abrasive,

wherein removing of said second metal film comprising forming a protection-layer with a forming agent, polishing the protection-layer away on a convex portion of the second metal film, oxidizing a surface of the convex portion of the second metal film by an oxidizing substance and rendering an oxidized second metal film water soluble by a phosphoric acid.

14. (Amended) A method for manufacturing a semiconductor device according to claim 13, wherein said second polishing liquid [has a similar composition to said first polishing liquid except that the former one further contains the abrasive] is comprised of an oxidizing substance, a phosphoric acid, a protection-layer forming agent and the abrasive.

16. (Amended) A method for manufacturing a semiconductor device, which comprises forming, over a semiconductor region, an insulating film having an opening, depositing a first metal film made of a barrier metal and a second metal film made of one selected from the group of Cu, an alloy composed mainly of Cu and a Cu compound over said

said opening with said deposited metal films, removing said second metal film from the surface of said first metal film over said insulating film by chemical mechanical polishing with a first polishing liquid containing hydrogen peroxide, a phosphoric acid, benzotriazole, and one selected from the group of polyacrylic acid, salt thereof, and a bridged polymer thereof but being free of an abrasive, thereby exposing the surface of said first metal film over said insulating film and said second metal film inside of said opening and removing said first metal film exposed over said insulating film by chemical mechanical polishing with a second polishing liquid containing an abrasive,

wherein removing of said second metal film comprises forming a protection layer with a forming agent, polishing the protection-layer away on a convex portion of the second metal film, oxidizing a surface of the convex portion of the second metal film by an oxidizing substance and rendering an oxidized second metal film water soluble by a phosphoric acid.

17. (Amended) A method for manufacturing a semiconductor device according to claim 16, wherein said second polishing liquid [has a similar composition to said

contains the abrasive] is comprised of an oxidizing substance, a phosphoric acid, a protection-layer forming agent and the abrasive.

19. (Amended) A metallization method comprising removing a first metal film which is formed over an insulating film and is made of a barrier metal and a second metal film which is formed over the surface of said first metal film and is made of one selected from the group of Cu, an alloy composed mainly of Cu and a Cu compound, wherein said second metal film is polished with an abrasive-free polishing liquid which contains an oxidizing substance, a phosphoric acid and a protection-layer forming agent, followed by polishing of said first metal film by dry etching,

wherein polishing of said second metal film comprises forming a protection-layer with a forming agent, polishing the protection-layer away on a convex portion of the second metal film, oxidizing a surface of the convex portion of the second metal film by an oxidizing substance and rendering an oxidized second metal film water soluble by phosphoric acid.

20. (Amended) A method for manufacturing a semiconductor device, which comprises forming, over a first

insulating layer having a groove extending to said first interconnect layer, depositing and stacking a first metal film made of a barrier metal and a second metal film made of one selected from the group of Cu, an alloy composed mainly of Cu and a Cu compound over said insulating film and inside of said groove, thereby filing said groove with said stacked metal films, removing said second metal film and said first metal film from the surface of said insulating film by chemical mechanical polishing with a polishing liquid containing an oxidizing substance a phosphoric acid and a protection-layer forming agent, thereby exposing said second metal film embedded in said groove, treating the exposed surface of said second metal film in said groove with plasma of a sub-atmospheric pressure, and allowing a second interconnect layer to adhere onto said second metal film exposed in said groove and to lay over the surface of said insulating film,

wherein polishing of said second metal film comprises forming a protection-layer with a forming agent, polishing the protection-layer away on a convex portion of the second metal film, oxidizing a surface of the convex portion of the second metal film by an oxidizing substance and rendering an oxidized second metal film water soluble by a